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Health Literacy, Sociodemographic Factors, and Cognitive Training in the ACTIVE Study of Older Adults

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Abstract

Objective.—Health literacy is critical for understanding information from healthcare providers and correct use of medications and includes the capacity to filter other information in navigating health care systems. Older adults with low health literacy exhibit more chronic health conditions, worse physical functioning, and poorer mental health. This study examined the relationship between sociodemographic variables and health literacy, and the impact of cognitive training on change in health literacy over 10 years in older adults.

Methods.—Participants (*N* = 2,802) aged 65 years and older completed assessments, including reading and numeracy health literacy items, as part of the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study. We evaluated baseline sociodemographic variables and change in health literacy over a 10-year period in individuals exposed to cognitive training in reasoning, processing speed, memory, or a no-contact control condition.

Results.—Age, sex, race, education level, and general cognitive functioning at baseline were all associated with baseline health literacy in older adults. Predictors of change in health literacy over

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the 10-year follow-up were age, race, education level, general cognitive functioning and neighborhood income; disparities in health literacy due to race attenuated over time, while the effect of age increased over time. Health literacy was generally stable across the ACTIVE intervention groups over 10 years.

Conclusions.—The present study showed important disparities in health literacy level and change over 10 years. Cognitive training did not significantly impact health literacy, suggesting that alternative approaches are needed to reduce the disparities.

Keywords

health literacy; older adults; health disparities; cognitive training

Health literacy has been defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions [1,2]. Health literacy is critical for understanding instructions from doctors, directions on drug bottles, and reading appointment slips, and includes the capacity to filter important information when negotiating health care systems [2]. Older adults with low health literacy report more chronic health conditions, worse physical functioning, and poorer mental health [2–9]. An estimated 80 million Americans have limited health literacy [2]. Low health literacy is more prevalent among racial and ethnic minorities, older adults, and individuals who have not completed high school, spoken a language other than English before starting school, or who are living in poverty [10]. In the 2003 National Assessment of Adult Literacy [10], the lowest category of health literacy ("below basic") was over-represented by Hispanic (41%), American Indian and Alaska Native (25%), Black (24%), and Asian (13%) respondents compared to White (9%) respondents. Many possible mediators and moderators of the relationship between health literacy and health outcomes have been explored, with evidence for some mediators (knowledge, patient self-efficacy, norms, and stigma) affecting the causal pathway for some health outcomes (adherence and diabetes control) and some moderators (social support and health care system characteristics) affecting the magnitude or direction of some outcomes (adherence and blood pressure control) [9]. However, predictors of health literacy and change in health literacy have not been explored in a large sample.

Managing one's health and navigating the health care system depends in part on a cognitive skill set [11]. Indeed, health literacy is typically assessed by screenings of reading and numeracy skills, such as the Test of Functional Health Literacy in Adults (TOHFLA) [12] and its shortened version (S-TOHFLA) [13], both involving items measuring the ability to understand healthcare and medication instructions, the Rapid Estimate of Adult Literacy in Medicine (REALM) [14] involving medical term recognition and pronunciation, and the Newest Vital Signs test (NVS) [15] involving comprehending health related information and numeracy. Such screening measures are significantly associated with both crystallized and fluid cognitive abilities [16–18].

Health literacy appears to remain relatively stable over time, but declines in older adulthood [11]. In a cross-sectional national survey, rates of low health literacy in those age 65 years and older were more than double that of adults age 50–64 years [10]. The relative stability of health literacy over time preceding cognitive decline may be due to the strong associations with general cognitive functioning and reading literacy [11,16,19].

Interventions to improve health literacy have limited or mixed success [20]. The challenge has been in developing effective behavioral and health system interventions that overcome the negative impact of an individual's limited comprehension of healthcare information [2,20]. Most interventions have focused on increasing knowledge, improving self-efficacy, and changing behavior [21]. In a review of 38 intervention studies for individuals with low health literacy, the design features that demonstrated effectiveness in improving patient comprehension included strategic presentation of essential information, and adding video or verbal narrative; a few studies reported that intensive self-management interventions reduced hospitalizations and emergency department visits, and intensive self- and disease-management interventions reduced the severity of the targeted disease [22]. Because health literacy is reflective of a cognitive skill set, improvement of health literacy through cognitive intervention may be one path for maintaining health in later life as well as maximizing benefit of medical check-ups and instructions from healthcare providers.

The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study [23] is a longitudinal randomized controlled trial that investigated whether cognitive training in late adulthood improved the cognitive abilities of community-dwelling older adults. The three intervention groups received ten training sessions in memory, reasoning, or processing speed. Participants who attended a minimum number of initial training sessions were eligible to receive additional booster sessions 11 and 35 months after initial training. At the 10-year follow-up, compared to the control group, participants in the processing speed intervention retained a medium-to-large improvement effect and participants in the reasoning intervention retained a small improvement effect in their respective cognitive domains. Results for memory training were not significant [24]. The intervention groups also exhibited fewer declines in activities of daily living than the control group.

The purpose of this study was threefold: 1) to investigate demographic associations with health literacy at baseline; 2) to examine predictors of health literacy over a 10-year follow up; and 3) to explore the impact of cognitive training interventions on health literacy in older adults in the ACTIVE project. Consistent with the literature, we hypothesized that lower health literacy would be associated with older age, racial/ethnic minority status, lower education, and lower socioeconomic status (SES). Further, we hypothesized that these demographic variables would predict changes in health literacy over time. Based on previous studies linking health literacy and cognitive functioning as well as the 10-year results of ACTIVE cognitive training, we also hypothesized that change over time in health literacy would be improved by randomization to ACTIVE domain-specific cognitive training interventions of reasoning and processing speed.

Method

Participants

ACTIVE is a randomized controlled trial of behavioral training interventions designed to improve cognitive abilities and functioning of independently-living older adults. At baseline, participants were English-speaking, cognitively healthy community-dwelling older adults (*N* = 2,802) between 65 and 94 years of age from six different sites across the eastern U.S. Participant characteristics are presented in Table 1. Details on the screening, eligibility criteria, and recruitment have been previously reported (Jobe et al., 2001). Briefly, individuals were excluded if they reported or showed evidence of: 1) cognitive impairment as assessed by a Mini-Mental State Exam (MMSE) (Folstein et al., 1975) score of ≤23; 2) functional dependence related to dressing, personal hygiene, or bathing; 3) medical conditions with high risk of functional decline, including dementia diagnosis and stroke; 4) previous participation in cognitive training interventions; and 5) vision, hearing, or communication impairments.

Measures

Health Literacy.—Nineteen variables from the ACTIVE assessments were identified as inquiring about either reading or numeracy health literacy. Health literacy relevant items were coded from the Everyday Problems Test (EPT) [25], the Observed Tasks of Daily Living (OTDL) [26,27], and the Timed Instrumental Activities of Daily Living tasks (TIADL) [28] (see Table 2). The EPT measures the ability to understand and solve problems involving printed materials with seven domains of daily living (i.e., food preparation, medication use, shopping, housekeeping, transportation, financial management, and telephone use). There are 15 different printed materials (e.g., medication label, a tax form) and for each printed material, participants must answer a question (or questions) about the stimulus (e.g., when shown a drug label, participants must identify the maximum drug dose over a 2-day period). The OTDL is a performance-based assessment of three IADLs – medication use, telephone use, and managing finances. Unlike the EPT, the OTDL assesses performance via direct observation of participant behavior. For example, a participant is given a medicine bottle and asked to read the directions printed on the bottle. The TIADL tests consisted of five common activities of daily living which required participants to search for, and process information regarding target objects or information (e.g., finding a telephone number in a phone book).

Sociodemographic Variables.—Demographic data were collected at baseline via telephone interview and included age, sex, years of education, and race. In this study, the race categories were coded as White, Black, or a combined "Other" category, which included Asian, American Indian/Alaska Native, Biracial, and "other race" (as listed in the ACTIVE study). A measure of SES, median neighborhood household income, was determined by geocoding the participant's address and linking this to census-tract data from the 2000 U.S. Census [29].

General Cognitive Functioning.—The MMSE is widely used to screen for cognitive impairment and assesses changes in cognitive functioning [30]. Scores range from 0–30 points; higher scores indicate better cognitive functioning.

ACTIVE Cognitive Training.—ACTIVE randomized participants to one of four groups: 1) memory training (*n*=703); 2) reasoning training (*n*=699); 3) processing speed training (*n*=702); or 4) no-contact control (*n*=698). The initial intervention consisted of 10 sessions of the assigned cognitive training. The sample was re-contacted for subsequent follow-up immediately following intervention (post-test) and again at 1-, 2-, 3-, 5-, and 10-years post-intervention. Standardized neuropsychological tests were administered to evaluate memory, reasoning, and processing speed. Specific details of each cognitive intervention and neuropsychological measures are presented elsewhere [23]. A vision test was also administered at each visit and coded on a scale from 0 to 100.

Analytic Strategy

A health literacy composite (HLC) score was constructed using factor analysis in Mplus 7.11 [31] with baseline data. The composite score was tested for unidimensionality and differential item functioning (DIF) due to race, age, sex, education, and an index of SES (Supplement 1). The baseline parameters were used to compute health literacy scores at follow-up. Scores were standardized (M=0, SD=1).

Linear regression was used to assess baseline associations. Mixed models with restricted maximum likelihood estimation and an unstructured covariance matrix were used for longitudinal analyses, except for testing the difference in change over time by intervention group, where maximum likelihood models were fit and an overall likelihood ratio test (LRT) of the effect of the time by intervention group terms was conducted. Race was categorized as White/Black/Other (including mixed race), except in the model examining interactions where Other race was included with White, due to the small number (n=47). As is common in literature using the ACTIVE dataset [24], all models controlled for baseline visual acuity, study site, and replication code.

Results

Health Literacy Composite (HLC)

Two items were not included in the composite due to lack of discordance and dimensionality issues (Table 2). Model fit for the 17-item HLC was excellent, and the impact of differential item function was negligible (see Supplement 1).

Baseline Associations with Health Literacy

Sex, race, age, education, general cognitive functioning, and vision at baseline were all significantly associated with level of health literacy, after controlling for site, visual acuity, and replication code (Table 3). Males had lower health literacy scores than females, and Black participants had lower health literacy scores than White participants. Older participants had lower health literacy scores than younger participants, and participants with fewer years of education had lower health literacy scores than those with more years of education. Lower general cognitive functioning, as measured by the MMSE, and poorer vision at baseline were also associated with lower health literacy scores. Neither median neighborhood household income nor the "Other" race category were associated with health literacy.

Change over Time in Health Literacy

Scores on the HLC did not change much until the 10-year visit, when they were 0.29 SD lower than at baseline. Female sex, Black race, older age, lower education, lower general cognitive functioning, lower neighborhood income, and poor vision all significantly predicted lower health literacy over the 10-year follow-up (Table 4).

When interactions were examined, several variables with significantly different baseline effects exhibited different rates of decline in health literacy over the 10-year time period (Table 5). Women had higher scores at baseline than men, and then lower scores at post-test, but after that their rates of decline (from baseline) were similar. Black participants had lower health literacy scores at baseline than White participants, but much of the health literacy difference was attenuated over time, with White participants exhibiting more decline. Compared to younger participants, older participants had lower health literacy scores at baseline and declined more quickly in health literacy over time.

ACTIVE Cognitive Training Intervention and Health Literacy

To investigate the effects of training in memory, reasoning, or processing speed on health literacy, the terms for the three intervention cognitive groups processing were entered into the model shown in Table 5. The intervention effects were non-significant for all three cognitive training interventions: (beta=0.025, 95% *CI* (−0.095, 0.045); p=0.478); reasoning (beta=−0.016, 95% CI (−0.054, 0.087); p=0.653); and processing speed (beta=0.007, 95% CI (−0.063, 0.077); p=0.841)). Further, the interventions did not affect the rate of change in health literacy (LRT p=0.838).

Discussion

The goals of the current analyses were to: 1) investigate predictors of health literacy at baseline; 2) explore changes in health literacy over a 10-year period and 3) investigate the effects of cognitive training on health literacy. At baseline, we found that health literacy was associated with age, sex, race, education, general cognitive functioning, and vision, in the expected directions. Median neighborhood household income, a proxy for SES, was not associated with health literacy at baseline in the ACTIVE cohort. Cognitive training did not influence health literacy level or change. Health literacy level remained stable over much of the follow-up period and only showed a marked change at the 10-year follow-up where it declined to 0.29 SD lower than at baseline. Baseline differences in health literacy by race were attenuated over time. Older participants showed faster health literacy declines over time compared to younger participants.

Consistent with the literature, baseline HLC scores in this study were associated with general cognitive functioning at baseline. Screening measures relating to cognitive aspects of health literacy have been significantly associated with both fluid (active learning and information processing) and crystalized (long-term memory and general knowledge) cognitive abilities [19]. Further, accounting for cognitive functioning reduces relationships between health literacy and physical health and between health literacy and depression [16]. However, other critical aspects thought to influence health literacy such as the ability to network and interact with others and use technology, understanding the disease process, motivation, and self-efficacy are not measured with the widely-used cognitive screening measures [32]. Similarly, we were not able to ascertain these other aspects of health literacy in our study.

Race, age, education, general cognitive functioning, and neighborhood income all significantly predicted health literacy over the 10-year follow-up. Our findings partially parallel those in a recent study of cognitive functioning and health literacy decline of adults age 52 and older over a 6-year period, in which participants who were older, male, non-White, had low educational attainment, low occupational class, or who exhibited lower cognitive functioning were more likely to evidence health literacy decline [19]. SES, although related to other demographic characteristics, has been uniquely associated with health literacy [33]. Our lack of an association with an index of SES and health literacy at baseline may be due to a restricted range in SES in the ACTIVE study [29], though we did note an effect on change over time. While race was associated with baseline health literacy scores and change of health literacy over time, the differences between Black and White participants attenuated over time with White participants exhibiting more decline. This is in contrast to the race findings in the Kobayashi et al. (2015) study in which non-White participants (42.4% Black and 7.0% Other) evidenced more health literacy decline. Our ACTIVE sample had smaller percentages of both Black (26%) and "Other race" (2%) than the Kobayashi et al. (2015) study, which may account for some of the discrepancy. Participants from the Kobayashi et al. (2015) study were from an academic internal medicine clinic and were, on average, less healthy than the ACTIVE participants, who, in order to participate in the cognitive training, were recruited if they were cognitively healthy, community-dwelling older adults who lived in close proximity to study sites where the cognitive training occurred.

In our study with individuals age 65 years and older, health literacy remained relatively stable over time until the 10-year follow-up, which is in contrast to cross-sectional studies of correlations between health literacy and age indicating a lower health literacy in older adulthood. In a review of 60 cross-sectional studies of adults age 50 years and older, older age was associated with more limited health literacy scores [11]. However, the extent of this association depended upon the measure of health literacy used, with stronger age associations found among health literacy measures of reading comprehension, reasoning, and numeracy skills, and weaker age associations among health literacy measures of medical vocabulary [19].

Our hypothesis that ACTIVE cognitive training would improve health literacy scores over the 10-year follow-up period was not supported. Since the HLC is comprised of items assessing cognitive skills, and other similar measures of health literacy are strongly associated with both fluid and crystalized cognitive functioning [19], we predicted cognitive training, especially in the speed and reasoning domains, which demonstrated significant training effects over time, would also impact health literacy scores over time. This null result may be due to the items of the HLC being related to health medication use, health care, health history, and food rather than tapping more directly into the cognitive domains of reasoning and processing speed. While cognitive training may result in improvements in specific cognitive domains, improving the complex array of skills and knowledge involved in managing one's health and health care is likely to encompass another layer of complexity. Indeed, health literacy interventions have shown limited or mixed results, with the most consistent positive results stemming from multiple discrete design features to scaffold comprehension and intensive self-management interventions that reduced emergency department visits and hospitalizations [20].

This study was not without limitations. 1) Our HLC score was created from three questionnaires not originally designed to measure health literacy. However, the items are similar to other widely used screening measures of the TOHFLA, REALM, and NVS. Further, our composite with older adults at baseline provided an excellent model fit and did not evidence differential item functioning with respect to age, race, sex, education, or an index of SES (see Supplement 1). Thus, our HLC appeared to provide a sound screening index of health literacy in older adults. Still, it is possible that some types of items were more sensitive to change with increasing age than others. 2) Due to inclusion criteria, the ACTIVE sample is comprised of relatively healthy older adults with little to no functional impairments at baseline. They were also a highly motivated sample interested in receiving cognitive training. These characteristics may help to explain why scores on the HLC remained relatively stable over the course of follow-up and did not show much change until the 10-year follow-up. It is also possible that the results were affected by selective survival based age, race, sex, and education. 3) ACTIVE did not sample American Indians/Alaska Natives or Asian Americans, two ethnic groups who have particularly low health literacy [10], or people for whom English was not their primary language. 4) We used the MMSE as the measure of general cognitive functioning, limiting investigations of associations among specific cognitive domains and health literacy, such as executive functioning, attention, language proficiency, and short and long-term verbal memory.

The findings in this study highlight the challenges of addressing low health literacy, improving general health status in older adults, and reducing health disparities. The concept of health literacy involves an array of cognitive, social, and personal skills, abilities, and knowledge necessary to successfully navigate the healthcare system and manage one's own health challenges. While cognitive abilities may not be readily improved in older adults, core academic skills and health-related knowledge can be improved with targeted interventions [34]. Increasing information-management skills and patient-provider interactions may improve health literacy in older adults [35], and health care professionals may need to spend more time with older patients with low health literacy for both information dissemination and information skills training. In a meta-review of patient adherence to medication in older adults, weak associations were found in improving health literacy in older adults by focusing on education and lowering instruction health literacy demands [36]. Increasing health literacy in underrepresented and underserved populations such as older racial/ethnic minorities will likely benefit from a community-based participatory research (CBPR) approach in the broader health research literature. CBPR has been successful in engaging underrepresented and underserved groups, such as racial/ethnic minorities and older adults, improving health outcomes and trust while developing partnerships among communities and researchers [37].

This study was the first to evaluate long-term change in health literacy over time in older adults in a cognitive training study, and we found that scores did not decline appreciably until 10 years after the first assessment. Differences by race attenuated over time, while the age effect grew stronger. Since none of the ACTIVE cognitive interventions mitigated this decline, other interventions targeting older adults should be pursued.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key-points:

- Older adults completed health literacy items at baseline and over a 10-year period as part of a cognitive training study.
- Baseline health literacy scores were associated with age, sex, race, education level, and general cognitive functioning, while predictors of health literacy change over the 10-year period were age, race, education level, general cognitive functioning, and neighborhood income.
- Health literacy was generally stable over the 10-year period suggesting cognitive training did not significantly impact health literacy.
- Alternative approaches to cognitive training are needed to reduce disparities in health literacy level.

Table 1.

Baseline Participant Characteristics

	N (%)	Mean baseline health literacy score (SD)
Age		
65–69	819 (29)	0.14 (1.00)
70–79	1,473 (53)	0.00 (0.97)
80–94	510 (18)	−0.62 (0.99)
Sex		
Female	2,126 (76)	−0.08 (1.01)
Male	676 (24)	−0.05 (1.04)
Education		
High school or less	1,117 (40)	−0.45 (1.00)
Post High school	1,683 (60)	0.18 (0.95)
Race		
White	2,028 (72)	0.11 (0.97)
Black	728 (26)	−0.57 (0.98)
Other [a]	46 (2)	−0.20 (1.10)
Mini-Mental State Exam		
23–26	884 (32)	−0.69 (0.95)
27–28	984 (35)	−0.02 (0.93)
29–30	934 (33)	0.45 (0.83)
Median neighborhood household income		
Bottom quartile	625 (25)	−0.37 (1.04)
Top 3 quartiles	1,894 (75)	0.24 (1.01)

Notes

[a]Includes Asian (n=7), American Indian/Alaskan Native (n=5), Biracial (n=9) and “Other” (n=26).

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Table 2.

Candidate items for the Health Literacy composite score

Item	Source	Final status
Medication name	OTDL	dropped due to 96% correct response
Days supply of medication	OTDL	included
Medication side effects	OTDL	included
Medication dose 1	OTDL	included
Medication frequency	OTDL	included
When to consult a doctor	OTDL	included
Reporting insurance coverage	OTDL	included
Anesthesia complications 1	OTDL	dropped due to higher correlation with *Anesthesia complications 2* than with the health literacy factor
Anesthesia complications 2	OTDL	included
Health history form 1	EPT	included
Health history form 2	EPT	included
Medication dose 2	EPT	included
Contraindications	EPT	included
Medical bill 1	EPT	included
Medical bill 2	EPT	included
Food label - sodium	EPT	included
Food label - calories	EPT	included
Time reading directions 1	TIADL	included
Time reading directions 2	TIADL	included

Notes: EPT = Everyday Problems Test; OTDL = Observations Tasks of Daily Living; TIADL = Timed Instrumental Activities of Daily Living.

Table 3.

Association of baseline sociodemographic and vision with health literacy composite score

Variable	Beta (95% CI)	p-value
Female	0.16 (0.09, 0.24)	< 0.001
Race		
White	(ref)	
Black	−0.53 (−0.61, −0.44)	< 0.001
Other [a]	−0.22 (−0.58, 0.15)	0.249
Age (10 years)	−0.36 (−0.42, −0.31)	< 0.001
Education (4 years)	0.40 (0.34, 0.45)	< 0.001
Mini-Mental State Exam	0.16 (0.15, 0.18)	< 0.001
Median neighborhood household income [b]	0.04 (−0.00, 0.08)	0.054
Vision score (10 points)	0.09 (0.06, 0.12)	< 0.001

Notes: Associations between baseline factors and health literacy, controlled for site and replication code.

[a] Includes Asian, American Indian/Alaskan Native, Biracial and “Other”.

[b] Standardized score for median household income in the participant’s census tract.

Table 4.

Baseline predictors of change over time in Health Literacy

Variable	Beta (95% CI)	p-value
Visit		
Post-test	0.07 (0.04, 0.11)	< 0.001
1 year	−0.05 (−0.08, −0.01)	0.005
2 year	0.04 (0.00, 0.07)	0.032
3 year	0.04 (0.01, 0.08)	0.023
5 year	−0.02 (−0.05, 0.02)	0.398
10 year	−0.29 (−0.34, −0.25)	< 0.001
Female	0.16 (−0.34, 0.21)	< 0.001
Race		
White	(ref)	
Black	−0.50 (−0.57, −0.43)	< 0.001
Other [a]	−0.14 (−0.44, 0.16)	0.370
Age (10 years)	−0.38 (−0.43, −0.33)	< 0.001
Education (4 years)	0.34 (0.30, 0.21)	< 0.001
Mini-Mental State Exam	0.16 (0.09, 0.17)	< 0.001
Median neighborhood household income [b]	0.04 (0.14, 0.07)	0.014
Vision score (10 points)	0.06 (0.04, 0.09)	< 0.001

Notes: Associations between baseline predictors of change over time and health literacy controlled for site and replication code.

[a.] Includes Asian, American Indian/Alaskan Native, Biracial and "Other".

[b.] Standardized score for median household income in zip code.

Table 5.

Baseline predictors of change over time in Health Literacy, with time interactions.

Variable	Beta (95% CI)	p-value
Visit		
Post-test	0.03 (−0.05, 0.11)	0.429
1 year	−0.12 (−0.21, −0.03)	0.006
2 year	−0.01 (−0.10, 0.08)	0.773
3 year	−0.02 (−0.11, 0.07)	0.689
5 year	−0.02 (−0.12, 0.08)	0.685
10 year	−0.23 (−0.34, −0.11)	< 0.001
Female	0.15 (0.07, 0.22)	< 0.001
Post-test	−0.10 (−0.18, −0.03)	0.005
1 year	0.06 (−0.02, 0.14)	0.120
2 year	0.03 (−0.05, 0.11)	0.471
3 year	0.07 (−0.01, 0.15)	0.087
5 year	0.08 (−0.01, 0.17)	0.086
10 year	0.05 (−0.06, 0.16)	0.396
Black[a]	−0.57 (−0.65, −0.48)	< 0.001
Post-test	0.05 (−0.02, 0.12)	0.178
1 year	0.09 (0.01, 0.16)	0.026
2 year	0.12 (0.05, 0.20)	0.002
3 year	0.14 (0.06, 0.22)	0.001
5 year	0.11 (0.02, 0.20)	0.012
10 year	0.13 (0.03, 0.24)	0.014
Age (10 years)	−0.39 (−0.45, −0.33)	< 0.001
Post-test	0.12 (0.07, 0.18)	< 0.001
1 year	0.00 (−0.05, 0.06)	0.910
2 year	−0.01 (−0.07, 0.05)	0.797
3 year	−0.04 (−0.10, 0.02)	0.186
5 year	−0.11 (−0.18, −0.04)	0.001
10 year	−0.21 (−0.30, −0.12)	< 0.001
Education (4 years)	0.34 (0.30, 0.39)	< 0.001
Mini-Mental State Exam	0.16 (0.14, 0.17)	< 0.001
Median neighborhood household income[b]	0.04 (0.01, 0.07)	0.014
Vision score (10 points)	0.06 (0.04, 0.09)	< 0.001

Notes: Associations between baseline predictors of change over time and health literacy controlled for site and replication code.

[a.]Asian, American Indian/Alaskan Native, Biracial and "Other" are grouped with White/Caucasian in this analysis.

[b] Standardized score for median household income in zip code.